2.—The Ocypode Ghost Crabs of Western Australia (Crustacea, Brachyura)

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Four species of *Ocypode* are recorded in Western Australia. Two, *O. ceratophthalma* and *O. cordimana* are widespread Indo-west Pacific species occurring along the northern coasts of Australia; the other two are probably Australian endemics, *O. convexa* occurring on the west coast and *O. fabricii* on the northern and upper west coasts of Australia.

The first male pleopod is figured and described for each species. A key and short descriptions are provided to enable adults and most subadults to be identified. Notes on the behaviour of the two probably endemic species are recorded.

Introduction

In recent years, active collecting has produced much crustacean material from Western Australia; perusal of the previous literature reveals inadequate comparisons of local and circum-Indian Ocean material in many instances.

This report deals with the genus *Ocypode*, pointing out several previous misidentifications in the literature. Full bibliographic treatment has been attempted for *O. fabricii* and *O. convexa* but not for *O. cordimana* and *O. ceratophthalma*. Catalogued specimens now housed in the Western Australian Museum are indicated by the abbreviation WAM preceding the catalogue number and the measurements given in the text are those of the length of the carapace.

Acknowledgments

We wish to record our appreciation to Dr. Isabella Gordon of the British Museum (Natural History), who kindly examined specimens of *Ocypode* identified as *O. kuhlii* in the collection of that Museum; to Dr. L. Bott of the Senckenberg Museum and Dr. Danièle Guinot of the Muséum National D'Histoire Naturelle who kindly made comparisons of our material with the holotypes of *O. nobilii* and *O. fabricii* respectively; to Dr. L. B. Holthuis of the Leiden Museum and Dr. J. Yaldwyn of the Australian Museum for photocopies of original descriptions; to Dr. F. H. Talbot of the South African Museum for the loan of specimens identified as *O. kuhlii* from East Africa; to Dr. A. Crosnier of the Centre D'Océanographie de Pointe-Noire for his advice; and to the many collectors of material dealt with in this paper, particularly those who made special efforts to secure crabs for us.

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First Male Pleopods

The general shapes of the first male pleopods of the four species of *Ocypode* examined are similar, consisting of a straight or slightly curved main shaft closely applied to the convex thorax *in vivo*. The term "upper surface" referred to in the text is that side of the pleopod exposed when the abdomen is pulled back. Descriptions were facilitated by removal of the entire pleopod followed by low power microscopic examination.

When viewed *directly above the upper surface*, the pleopod of some species, e.g. *O. ceratophthalma* (fig. 1A), can be easily subdivided into main shaft, constricted "neck" and expanded "head". The head when viewed *obliquely* or *laterally* is expanded for all species examined. The head of each pleopod curves outward to terminate in a hard chitinous tip. The main shaft of all species is covered with sparse pubescence.

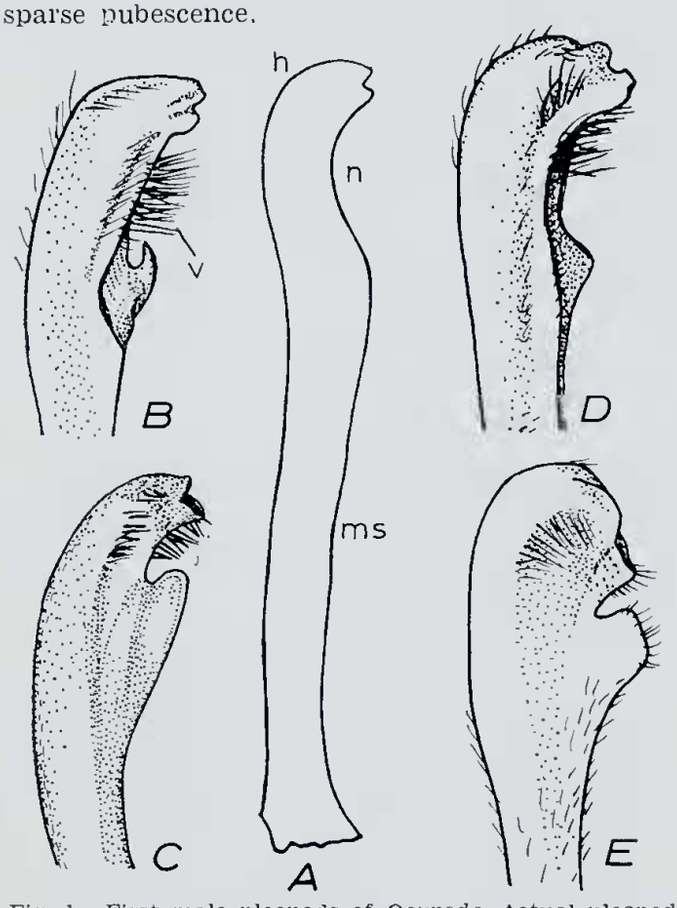

Fig. 1.—First male pleopods of *Ocypode*. Actual pleopod lengths given: **A. B.** *O. ceratophthalma* (18.1 mm); **C.** *O. cordimana* (14.9 mm); **D.** *O. fabricii* (15.8 mm); **E.** *O. convexa* (16.9 mm). A, viewed directly above upper surface, pubescence omitted; B C D E, head viewed obliquely from upper outer aspect. m.s. = main shaft, n. = neck, h. = head, v. = vibrissae. Drawn by Miss R. Hunt.

The diagnostic features are: the shape of the distal expansion of the lower surface ridge, the arrangement of the vibrissae on the head, and the form and position of the chitinous tip surrounding the distal aperture.

The figures are of the head of the left pleopod viewed obliquely from the upper, outer aspect. Measurements of total pleopod lengths are given in the figure legends.

Ocypode Weber 1795

Type species.—*Cancer ceratophthalmus* Pallas, 1772.

The diagnostic features of the genus are fully described by Alcock (1900, p. 344). The spellings *Ocypode* and *Ocypoda* have both been used by previous workers for this genus and here the spelling *Ocypode* is adopted in view of the recommendations made to the International Commission on Zoological Nomenclature by Holthuis (1962, pp. 237, 244 and 245).

Representatives of this genus occur on the Tropic and Subtropic coasts of all the major oceans of the world and the largest number of species have evolved in the Indo-west Pacific region. Although we have not attempted a complete review of the genus, it would appear that there are 14 species in the Indo-west Pacific, three in the Atlantic and two in the East Pacific regions. Current research on this genus by the French workers, Drs. Guinot and Crosnier, will no doubt help to clarify the taxonomy of the group.

Major revisions of this genus have previously been given by such workers as Kingsley (1880), Miers (1882) and Ortmann (1894 and 1897); and valuable contributions to the Indo-pacific *Ocypode* species have been published by Alcock (1900) and Tesch (1918). Most of these workers recorded variations in some characters (particularly length of ocular stylet and shape of outer orbital angle) yet these variable characters have sometimes been used in the construction of their identification keys. This has led to some misidentifications, particularly of subadult and juvenile specimens.

The diagnoses and the key given here are designed to facilitate the identification of adult and most subadult specimens of the four Western Australian species of *Ocypode;* only tentative identifications are possible for extremely juvenile specimens.

Close microscopic examination of these juveniles revealed certain adult characters which could be relied upon, and some which could not.

When examined microscopically (particularly if dry), the stridulating organ is possibly the best character on which to base an identification. Although it may be extremely difficult to accurately count the components of the juvenile stridulating organ, it is easy to see the actual type of structures of which it is composed. For example, the stridulating organ of juvenile *O. ceratophthalma* is obviously composed of two different types of structures, whereas in *O. fabricii,* the stridulating organ is composed of only one type of structure, transverse ridges; and these are obviously different from the arrangement of separate tubercles that forms the stridulating organ of *O. convexa.*

In the juveniles, the leg hairbrushes are represented by sparse lines of hair compared with the dense brushes developed in the adult. In the species from Western Australia, the general shape of the orbit and outer orbital angle vary little from juvenile to adult. In other species from other areas, e.g. *O. saratan* these vary with size, as discussed later.

Key to the Western Australian species of Ocypode

1.	Palm of large cheliped with stridulating organ	2	
	Palm of large cheliped without stridulating organ		*O. cordimana*
2.	(1) Stridulating organ solely or partly composed of transverse ridges	3	
	Stridulating organ solely composed of roundish tubercles (10-25); lower orbital edge with a deep lateral and a deep median notch		*O. convexa*
3.	(2) Stridulating organ composed of round and/or elongated tubercles in the upper part and transverse ridges in the lower; lower orbital edge with no lateral notch		*O. ceratophthalma*
	Stridulating organ composed solely of fine transverse ridges (108-141); lower orbital edge with a broad, U-shaped lateral notch		*O. fabricii*

Ocypode cordimana Desmarest

(Fig. 2A)

Ocypode cordimana; Desmarest 1825, p. 121; Stimpson 1907, p. 110; Boone 1934, p. 191.

Ocypode cordimana; Kingsley 1880, p. 185; Haswell 1882, p. 95; Miers 1882, p. 387; Alcock 1900, p. 349; Tesch 1918, p. 35; Sakai 1939, p. 613.

Ocypode cordimanus; Barnard 1950, p. 84.

Diagnostic features.—No stridulating organ on palm of large cheliped. Lower orbital edge with a broad key-hole shaped lateral notch and a very slight median notch. Eyes without stylets. Outer orbital corners acute, directed forwards. Anterior upper border of propodus of second and third pereiopod in male with single hairbrush; in female, single hairbrush on second pereiopod only. Inner dorsal margin of merus of large cheliped with curved, toothed flange. Inner margin of carpus of large cheliped with single main tooth and very small subsidiary teeth; outer distal margin of carpus granulate, without distinct teeth.

Description of male pleopod (Fig. 1, C, WAM 27-63).—Viewed directly above upper surface, main shaft not expanded to form distinct head. Lower surface of shaft with ridge terminating in an expanded, smooth, oval lobe proximal to head. Tip bilobed, straight-edged, obliquely-directed. Upper and lower margins of outer surface of head each with a fringe of short vibrissae.

Material examined

Western Australia.—One male (28.3 mm) and one female (25.5 mm) East Montalivet Is. (west of Darwin), A. Whitworth on "DOROTHEA", 21.x.1962, WAM 27-63 and 140-63.

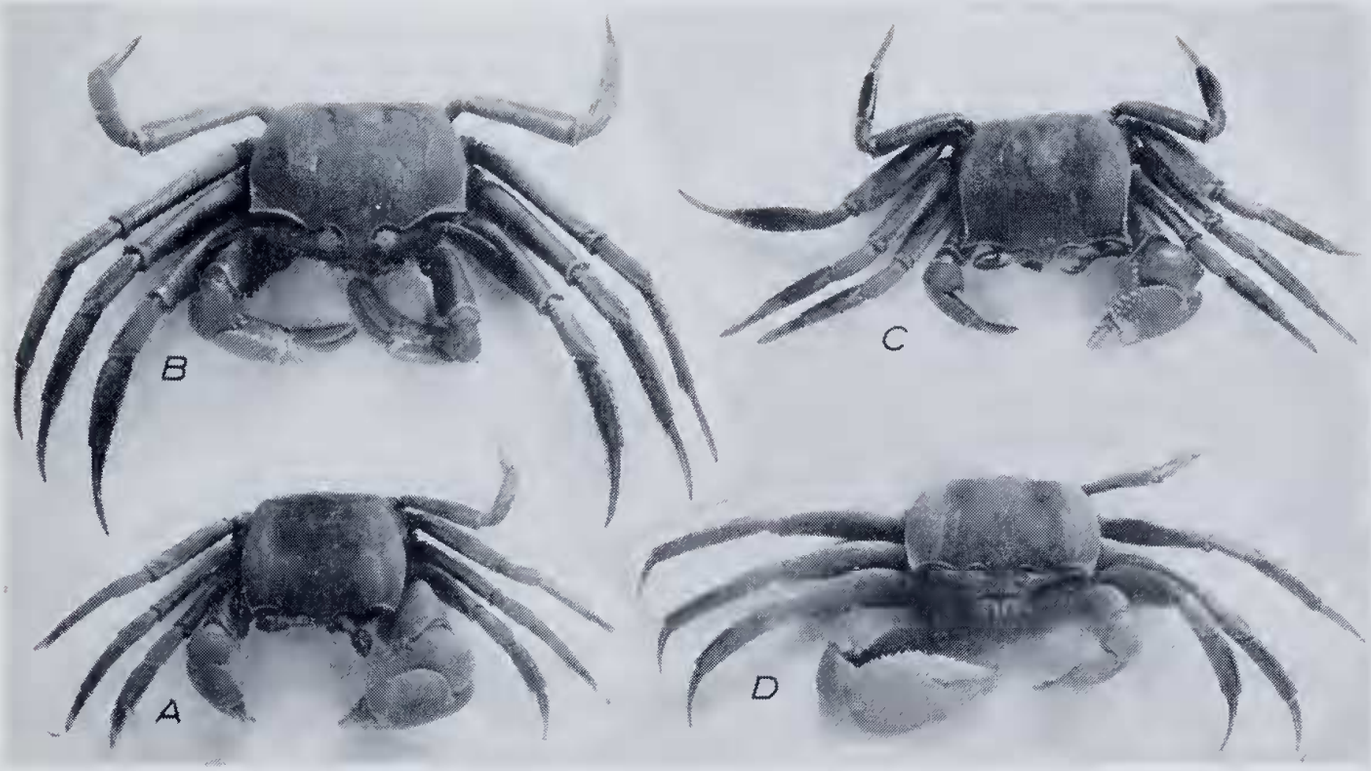

Fig. 2.—Male *Ocypode* from Western Australia. **A**. *O. cordimana* WAM 27-63; **B**. *O. ceratophthalma* WAM 20-64; **C**. *O. fabricii* WAM 4-64, **D**. *O. convexa* WAM 24-63.

Other localities.—Two immature males (10.2 and 11.6 mm) Ashmore Reef, Timor Sea, J. McIntyre, C.S.I.R.O., August 1961, W.A.M. 28-63; four juveniles (4.0 to 8.2 mm) Marion Reef, Paget Island, Coral Sea, G. F. Mees, 25.xi. 1961, WAM 76-63; two males (16.5 and 13.8 mm) south end Heron Island, Queensland, R. W. George, 23.v.1961, WAM 74-63: one male (14.1 mm) Urunga, near Coff's Harbour, New South Wales, Mrs. R. W. George, 1.x.1959, WAM 75-63.

Distribution.—"Mauritius, east coast of Africa to Red Sea, Indo-pacific to Japan" (Barnard), East Australia (Haswell); now recorded from Western Australia. The type locality is Ile de France (Mauritius)—see Boone 1934, p. 191.

Ocypode ceratophthalma (Pallas)

(Fig. 2B)

Cancer ceratophthalmus Pallas 1772, p. 83, pl. 5, figs. 7 and 8.

Ocypoda ceratophthalma; Miers 1882, p. 379; Miers 1886, p. 238; Alcock 1900, p. 345; Tesch 1918, p. 36; Balss 1935, p. 140; Sakai 1939, p. 614; Gillett and McNeill 1962, pl. 118.

Ocypode ceratophthalma; Edmondson 1946, p. 310; Tweedie 1950, p. 321 (feeding behaviour).

Oeypode ceratophthalmus; Barnard 1950, p. 86.

Ocypode kuhlii; Miers 1882, p. 384 (part) and 1884, p. 237 (part).

Diagnostic features.—Stridulating organ on palm of large cheliped consists of round and/or elongated granules in the upper part and fine transverse ridges in the lower, margined distally by sparse pubescence in females and a dense hairbrush in males. Lower orbital margin without median or lateral notches. In our series, specimens over 24 mm with distinct ocular stylets, length of the stylet usually in proportion with length of carapace; specimens less than 24 mm with rudimentary or no ocular stylet. At equivalent size, males have longer ocular stylets. Outer orbital corners right-angled and outwardly directed. Anterior surface of propodus of second and third pereiopods of male with triple hairbrush; females with single hairbrush and few scattered hairs. Inner dorsal margin of merus of large cheliped almost straight, toothed; without flange. Inner margin of carpus of large cheliped with single main tooth (a number of subsidiary teeth develop in large specimens); outer distal margin of carpus denticulate.

Description of male pleopod (Fig. 1. A, B, WAM 20-64).—Viewed directly above upper surface, main shaft constricted to form neck and expanded distally to form head. Lower surface of shaft with ridge terminating in small, smooth, acute projection proximal to head. Tip bilobed, almost straight-edged, longitudinally-directed. Outer margin of head with double fringe of long vibrissae.

Material examined

Western Australia.—Ten males (26.1-38.4 mm), thirteen females (24.3-36.5 mm) and six juveniles (6.7-19.0 mm) from fifteen separate localities between East Montalivet Is. and Dorre I., Shark Bay. WAM 66-55, 69-55, 33-63, 34-63, 78-63, 79-63, 81-63, 83-63, 85-63, 86-63, 88-63, 90-63, 91-63, 93-63, 94-63, 95-63, 98-63, 136-63, 143-63, 19-64, 20-64.

Other localities.—Five males (26.9-35.2 mm), three females (29.8-33.0 mm) and two juveniles (8.2 and 12.8 mm) from the following localities: Penang; Christmas I. and Cocos Is., Indian Ocean; Heron I., Queensland; Port Macquarie and Forster, New South Wales. WAM 80-63, 82-63, 84-63, 87-63, 89-63, 92-63, 96-63.

Comments.—Miers (1882, p. 385) recorded "a series of rather smaller specimens" of *O. kuhlii* from Thursday Island. However, re-examination of three of his specimens by Dr. Gordon at the British Museum and of another small specimen by us from the Australian Museum, showed that they were all juvenile *O. ceratophthalma*. Further, Dr. Gordon examined the remaining material, recorded by Miers (1882, p. 385) as *O. kuhlii* (except the female from Japan which could not be located), and states (pers. comm.) "Although Miers seems to have adopted de Man's characters for *O. "kuhlii"* in his paper, the fact remains that not one of his specimens of supposed "kuhlii" agrees with de Man's description of the two specimens in the Leiden Museum. Until someone re-examines and figures *O. "kuhlii"* holotype from Java, I cannot be sure that any material so-called in our collection belongs to that species." The Shark Bay record of *O. kuhlii* by Miers 1882 is in fact *O. convexa* (discussed later).

Distribution.—"Mauritius, east coast of Africa to Red Sea, Indo-pacific" (Barnard). The type locality is India.

Ocypode fabricii Milne Edwards

(Fig. 2C)

Ocypoda fabricii Milne-Edwards 1837, p. 47 and 1852, p. 142.

Ocypoda aegyptiaca; Balss 1935, p. 140.

Non *O. fabricii,* Kingsley 1880, p. 182.

Diagnostic features.—Stridulating organ on palm of large cheliped composed of 108-141 extremely fine transverse ridges, accompanied distally by a dense patch of pubescence in males and scattered hairs in females. Lower orbital edge with a broad median notch and a U-shaped lateral notch. Stylets on eyes very short. Outer orbital corners very acute, usually directed outwards. Anterior surface of propodus of second pereiopod with triple hairbrush (largest male 37.9 mm), double hairbrush (other males) or single hairbrush (females). Distal half of anterior surface of propodus of third pereiopod with single hairbrush (largest male) or sparse or absent (remainder of material). Inner dorsal margin of merus of large cheliped straight with regular denticles along proximal half, distal half with clusters of irregular teeth. Inner margin of carpus of large cheliped irregularly toothed with two (subadult) to nine teeth (female 29.8 mm).

Description of male pleopod (Fig. 1. D, WAM 4-64.—Viewed directly above upper surface, main shaft expanded to form head but not markedly constricted to form neck. Lower surface with ridge terminating in a very low, smooth, bulbous expansion proximal to head. Tip trilobed, spooned, longitudinally-directed; distal aperture opens between the two proximal lobes. Outer margin of upper surface of head with two tufts of long vibrissae.

Material examined.—One male (17.6 mm) East Montalivet Is., A. Whitworth on "DOROTHEA", 21.x.1962, WAM 102-63; one female (16.6 mm) Derby, Driver Stuart, March 1945, WAM 277-45; two males (19.4 and 19.8 mm) Yampi Sound, G. A. Robinson, March 1959, WAM 103-63; two juveniles (9.8 and 11.2 mm) Yampi Sound, G. A. Robinson, July/August 1960, WAM 105-63; one female (30.3 mm) Adele I., W. Goode on "DOROTHEA", 19.x.1962, WAM 100-63; one female (recently moulted) (32.2mm) Crab Creek, Broome, M. C. MacDonald, 12.i.1962, WAM 138-63; one female (29.8 mm) probably Broome, E. J. Stuart, 1917, WAM 9391; one juvenile (11.0 mm) Legendre I., Dampier Archipelago, H. Williams and M. C. MacDonald, 10.vi.1962, WAM 97-63; two males (13.9 mm) three females (16.5 to 18.5 mm) one juvenile (8.5 mm) Dolphin I., Dampier Archipelago, R. D. Royce on "DAVENA", 29.v.1960, WAM 30-63; one female (18.4 mm) four males (12.7 to 24.5) and one (abdomen damaged) (11.7 mm) between east and west Lewis Is., Dampier Archipelago, B. R. Wilson on "DAVENA", 12.vi.1960, WAM 104-63; one female (23.5 mm) Shark Bay, Mrs. J. Watson, May 1961, WAM 101-63; one male (29.4 mm) and one female (31.3 mm) Denham, Shark Bay, B. R. Wilson, 29.xii.1959, WAM 145-63 (donated to Paris Museum); one male (37.9 mm) Denham's Hummock east side of Shark Bay, R. Slack-Smith, 9.i.1963, WAM 144-63; two males (32.8, 34.7 mm) and one female (33.1 mm) Little Lagoon, 1½ mile N. Denham, Shark Bay, D. Bathgate, 12.iii,1964, WAM 4-64, 18-64; one male (21.4 mm) unknown locality 9390; one ovigerous female (30.8 mm) unknown locality WAM 99-63 donated to Senckenberg Museum.

Comments.—Milne Edwards (1837) gave only a very general description of this species, unaccompanied by illustrations; and this species has remained in relative obscurity after Miers (1882) and Ortmann (1897) included *O. fabricii* with *O. ceratophthalma*. Their reasons for this procedure were based on an erroneous description given by Kingsley (1880) whose specimens from Australia and Natal are not *O. fabricii* since they had tubercles in place of fine striae on the stridulating ridge.

In view of the previous obscurity of *O. fabricii*, we initially believed that our material belonged to an unknown species so we are indebted to Dr. Crosnier for suggesting correctly, that our Western Australian material of this species might be *O. fabricii*. He has recently been studying *Ocypode* and other genera from Madagascar for which he examined closely the type of *O. fabricii*. On his suggestion, we sent several of our specimens to Dr. Danièle Guinot, Museum National D'Histoire Naturelle, Paris, for direct comparison with the holotype of *O. fabricii* and she reports that our specimens agree with the holotype from "Océanie". The precise locality of the holotype is not known but since our material and two specimens of this species which Dr. Guinot has seen from "west of Darwin", are all Australian in origin, it is likely that the holotype was collected in the western part of Oceania, if not Australia.

No specimens of this species were found in the collections of the British Museum or the Zoological Survey of India when one of us (R.W.G.) examined them in 1963; there were however some specimens from Northern Australia incorrectly identified as *O. kuhlii* in the Singapore Museum.

On the basis of the number of striae in the stridulating organ *O. fabricii* closely resembles *O. nobilii* de Man, 1902. The stridulating ridge of the *O. nobilii* male holotype (18 mm c.l.) is formed of approximately 115 transverse striae. A personal report by Nobili to de Man (1902, p. 481) records a large male (21 mm) with 120 transverse striae. An adult female (WAM 99-63) and small males and females (WAM 30-63) of *O fabricii* were sent to Dr. Bott of the Senckenberg Museum for comparison with the holotype of *O. nobilii*. He regarded the holotype male of *O. nobilii* as an adult which clearly differed from the specimens of *O. fabricii* sent for comparison. He pointed out that the most striking difference between the species, apart from the much greater size of *O. fabricii*, was the shape of the merus of the walking legs. The ratio of the length to breadth of the merus of pereiopod 4 in *O. nobilii* is 2.6 whereas in *O. fabricii* this ratio is 3.25. Another distinguishing feature is the shape of the lateral notch on the lower margin of the orbit; in *O. nobilii* it is shallow and obtuse but in *O. fabricii* it is deep and U-shaped.

Balss (1935, p. 140) identified an adult specimen from Shark Bay as *O. aegyptiaca* Gerstaecker 1856 and he probably used Ortmann's (1897) key for his identification. Indeed all our specimens of *O. fabricii* key out closest to that species using Ortmann's key. In addition, Balss regarded his Shark Bay specimen as conspecific with *O. aegyptiaca* specimens from the Red Sea; in our opinion, his Red Sea specimens were not adult, but subadult animals. Miers (1882, p. 382) noted that the shape of the orbital corners and the length of the ocular stylet of *O. aegyptiaca* vary with size and this observation was confirmed when one of us (R.W.G.) collected a series of the common Red Sea ghost crab from East Aden Protectorate in March 1963. This collection was made during a short term crayfish assignment with the F.A.O. United Nations (FAO/UN 1963).

Holthuis (1958) pointed out that Forskål's (1775) name of *O. saratan* for the Red Sea ghost crab is valid and antedates *O. aegyptiaca* Gerstaecker (1856). The comparison of our East Aden series of *O. saratan* with local material is represented diagrammatically in Figure 3; there is little obvious difference between the subadult *O. saratan* (fig. 3. B, C) and adult *O. fabricii* from Shark Bay (fig. 3. D, E). The two species can be readily distinguished at most stages of growth by the 100 or more fine striae in the stridulating ridge of *O. fabricii* compared with 60-100 striae on the stridulating organ of *O. saratan*. The notched form of the outer orbital angles of *O. saratan* as figured by Laurie (1915, p. 467) is represented in four of our nine adults from East Aden and all our adults have the stylet recurved posteriorly, not anteriorly as shown by Laurie.

It is also noteworthy that the juveniles of *O. saratan* from East Aden would be identified as *O. kuhlii* using the key produced by Miers (1882). It is not unlikely that juveniles of this species and other species (see comments on *O. ceratophthalma*) have in the past been designated *O. kuhlii*.

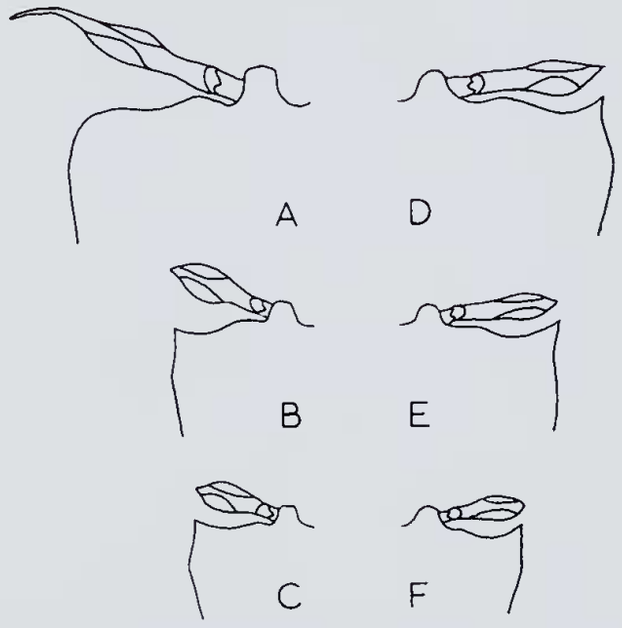

Fig. 3.—Growth Changes of *Ocypode*. **A-C**; *O. saratan*, East Aden Protectorate WAM 142-63. A male 42.2 mm. B female 22.5 mm, C female 18.6 mm; **D-F**: *O. fabricii*, Western Australia. D WAM 144-63 male 37.9 mm, E WAM 145-63 female 31.3 mm, F WAM 104-63 male 18.3 mm. Measurements are those of the carapace length.

Distribution.—North and west coasts of Australia from East Montalivet Is. (west of Darwin) to Shark Bay. The type locality is "Oceanie".

Ocypode convexa Quoy and Gaimard

(Fig. 2D)

Ocypode convexus Quoy and Gaimard 1824, p. 525.

Ocypoda convexus; Kingsley 1880, p. 185.

Ocypoda kuhlii; Miers 1882, p. 384 (part).

Ocypode pygoides Ortmann 1894, p. 766 and 1897, p. 362; Montgomery 1931, p. 451 (sic *pygioides);* Ride 1962, p. 17.

Ocypoda pygoides; Balss 1935, p. 140.

non *O. convexa;* Stimpson 1858, p. 100 and 1907, p. 109 = *O. stimpsoni* Ortmann 1897, p. 364.

non *O. convexa* Nobili 1900, p. 518 = *O. nobilii* de Man 1902, p. 478.

Diagnostic features.—Stridulating organ of 10 to 25 roundish tubercles. Lower orbital edge with two deep notches, one central and one lateral. Eyes without stylets. Outer orbital corner acute, directed forwards. Propodus of second and third pereiopods with single hair brush on upper anterior surface. Inner dorsal margin of merus of large cheliped with curved toothed flange. Inner margin of carpus of at least one cheliped with distinct bifid tooth.

Description of male pleopod (Fig. 1. E, WAM 24-63).— Viewed directly above upper surface, main shaft not expanded to form distinct head. Lower surface of shaft with ridge terminating in a well-developed, rounded, pubescent lobe proximal to head. Tip bilobed, straight-edged vertically-directed. Upper and lower outer margins of head each with fringe of short vibrissae.

Material examined.—Twenty nine males (20.1-42.5 mm), twenty-six females (18.7-38.4 mm) and twenty-seven juveniles (7.5-20.0 mm) from twenty-one West Australian localities from Barrow I., and between North West Cape and Yal-

lingup. WAM 7662, 7726, 9492, 9613, 9980, 10032, 10455/8, 128/9-46, 24/26-63, 49/73-63, 77-63, 106-63, 107-63, 137-63, 13-64.

Comments.—There is little doubt that Ortmann's suspicion (1897, p. 362) that his name *O. pygoides* is synonymous with *O. convexa* is true. Quoy and Gaimard's original figure and short description of *O. convexa* agree with the material examined here. Kingsley (1880, p. 185) and Miers (1882, p. 385) noted the features of the bifid tooth on the carpus of the cheliped and the hairbrush on the second and third pereiopods; both these features are clearly seen in Quoy and Gaimard's figure (in the figure, the hairbrush on right second pereiopod has not been illustrated). Miers thought *O. convexa* might be referred to either *O. kuhlii* or *O. cordimana* but *O. cordimana* lacks a stridulating organ on the palm of the cheliped and according to de Man (1881, p. 252), *O. kuhlii* lacks the propodal hairbrushes. In 1960, Dr. Gordon reexamined the male from Shark Bay which Miers (1882) identified as *O. kuhlii* and concluded that it was an adult *O. convexa*.

Distribution.—West coast of Western Australia, from North West Cape to Yallingup and also Barrow I. The record by Balss (1935) from Barrow Island is confirmed. The type locality is Dirk Hartogs Island, Shark Bay.

General Observations and Behaviour

The ghost crabs of Western Australia do not as a rule leave their sand burrows during the day; at night they forage along the strand lines of the beaches, retreating to their burrows or to the sea if disturbed. The burrows of all Western Australian species are near-ventical with simple openings; the excavated sand is carried away from the burrow mouth and dispersed. At Montalivet Is. three species, *O. cordimana*, *O. ceratophthalma* and *O. fabricii* were dug from burrows on one beach and the burrows were not obviously different. However, it is likely that on closer examination, differences in burrow position, shape or construction might be discovered.

By comparison, the appearance of *O. saratan* in the East Aden Protectorate is the daylight feature of the beaches; their burrows are well marked by large volcano-shaped piles of sand alongside the burrow mouths. The crab carries out an "armful" of sand, climbs to the top of the pile and deposits a load there each time.

During the winter of 1961, Mr. J. Brouwer studied a number of burrows of juvenile *O. convexa* at City Beach, near Perth, and he found that the entrances were all well above high water mark and 45-60 feet from the edge of the sea. The burrows were more or less vertical but all entrances were south of the bottom of the burrow, presumably to prevent sunlight from penetrating the burrow.

Mr. Brouwer also recorded that these juveniles survived immersion in freshwater for 12 hours and on release were able to dig burrows again. At Bernier Is., Shark Bay, Ride (1962) reported adult *O. convexa* (as *O. pygoides*) foraging up to one-third of a mile inland following heavy rain. The ability of *O. convexa* to withstand immersion in freshwater and to actively forage in rain-soaked vegetation may also apply to other species; perhaps de Man's (1888, p. 108) record of *O. cordimana* in freshwater at Sullivan I. and Mier's (1886, p. 239) record of *Ocypode* sp. in freshwater at Fiji are similar examples.

The following observations on *O. fabricii* by Mr. D. G. Bathgate at the Little Lagoon, 1½ miles north of Denham, Shark Bay, on the 12.iii.64 are also worthy of recording here. The official maximum shade temperature at Denham on that day was 114 deg. F. at 1300 hours. Mr. Bathgate's observations on the behaviour of the crabs from 0930 to 1630 hours were almost certainly in response to the very hot, dry conditions when the temperature and water loss of the crabs would be unusually high.

The normal burrows along the beach at Little Lagoon were about 3 feet above the high water mark at 2 feet in depth but remarkably, they were not occupied by crabs during the above daylight observations; about 30 burrows were investigated by Mr. Bathgate and found to be empty. The crabs were actively engaged in digging temporary burrows closer to the water line. The burrows were only about 1 foot from the water line; the completed burrow ran obliquely a distance of about 6 inches, where it reached the water table.

The most remarkable aspect of the crab's behaviour was the fairly regular and very rapid visits to the water in the lagoon to completely submerge for about 2-3 minutes. They returned more slowly to the temporary burrow; there to continue digging, first at the burrow mouth and then deeper in the burrow. About five visits to the burrow were required to excavate the burrow to 6 inch depth; subsequent visits to the same burrow were continued until a total of about 20 visits were made (approximately 2½ hours' duration) after which the crab may commence digging at a new burrow site.

On his return to the area in the cool of the night, Mr. Bathgate noted that the temporary burrows were not being used and were only faintly recognisable, as the rising tide had almost erased them. The crabs at this time were behaving normally, foraging near the stand line and retreating, when disturbed, to their permanent burrows or to the waters of the lagoon.

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